Interim Data Report

MetalMapper System: Camp San Luis Obispo Discrimination Study

ESTCP Project MM-0603

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1. Introduction

Data collection with the MetalMapper system in support of **2009 ESTCP Discrimination Study, San Luis Obispo, CA** commenced on 25 May and continued until 16 June. Allowing for the 4-day break we took from 4-7 June, the data collection required 19 field days. All operations were conducted in accordance with the draft demonstration plan that we submitted prior to mobilizing to San Luis Obispo (SLO) [1]. Table 1 contains a log of daily activities. Based on that table, approximately 12 field days were required for the dynamic (detection mapping) part of the demonstration while 7 days were spent in performing the static ("Cued ID") survey.

Table 1: Breakdown of field activities during the MetalMapper demonstration at SLO.

Date	Activities	Survey Area	SLO Blks	Sub-Area	Dyn File Root	Static File Root	File #'s	Comment
5/25/2009	Setup; Dynamic Survey	NWA	J12,J13	N/A	SLODyn	N/A	1-47	
5/26/2009	Dynamic Survey	NWB	I10, I11, I12	N/A	"	N/A	48-101	
	Dynamic Survey	NWC	F10-H11 (6Blks)	NWCa	"	N/A	102-175	Surveyed w/ SW-NE lines
5/27/2009	Dynamic Survey	NWC	"	NWCa	"	N/A	176-232	
5/28/2009	Dynamic Survey	NWC	"	NWCb	"	N/A	233-254	
5/28/2009	Dynamic Survey	SPlus	I5,J4,J5	SWA	"	N/A	255-338	
5/29/2009	Dynamic Survey	SPlus	K4-K9	SA	"	N/A	339-424	
5/30/2009	Dynamic Survey	SEPlus	L5,L6, M5 & Parts of M6 and L7	SE	"	N/A	425-516	
	Dynamic Survey	SEPlus	of M6,L7, L9,M8, and N7	SE-A	"	N/A	517-576	
5/31/2009	Dynamic Survey	E	Parts of L9,M8,N7; N8,O8,M9,N9;parts of M10,O9,P9	N/A	"	N/A	577-687	
6/1/2009	Dynamic Survey	NEPlus	N11,N12,O10-O12,P9-	NE	"	N/A		
6/2/2009	Dynamic Survey		P11	NEa	"	N/A		
6/3/2009	Static Survey	Test Strip	N/A	N/A	N/A	SLOStat	2-22	
	Static Survey	Test Pit	N/A	N/A	N/A	"	23-56	
6/4/2009	BREAK							
6/5/2009								
6/6/2009								
6/7/2009								
6/8/2009	Static Survey	Test Pit			N/A	SLOStat	2-21	Checkout Config Problem
	Static Survey	Test Strip			N/A	SLOStat	57-68	Repeat Test Strip (6/3/09)
	Dynamic Survey	Test Pit			headcorr	N/A	1-8	Conduct Mag Hdg Comp Experiment
	Static Survey	NWC		NWCa	N/A	SLOStatA	1-217	Start Static Survey
6/9/2009	Dynamic Survey	N	K14,L14,M14,L15	Nn	SLODyn	N/A	864-945	
	Dynamic Survey	N	K13,L13,M13,N13	Ns	"	N/A	947-1061	
6/10/2009	Static Survey	NWB		N/A	N/A	SLOStatA	218-363	
	Static Survey	NWC		NWCb	N/A	SLOStatA	364-489	
	Static Survey	NWA		N/A	N/A	SLOStatA	490-524	
6/11/2009	Static Survey	NEPlus		N/A	N/A	SLOStatA	525-795	
	Static Survey	E		N/A	N/A	SLOStatA	796-952	
6/12/2009	Static Survey	E		N/A	N/A	SLOStatA	953-1205	
	Static Survey	SEPlus		N/A	N/A	SLOStatA	1206-1434	
6/13/2009	Static Survey	SPlus		N/A	N/A	SLOStatA	1435-1859	
6/14/2009	Static Survey	N		N/A	N/A	SLOStatA	1860-2178	
6/15/2009	Dynamic Survey	NWB	I10-I12	N/A	SLODyn	N/A	1062-1105	Resurvey NWB (QC check)
	Static Survey	StatRep		N/A	N/A	SLOStatA	2179-2282	QC Repeats +
6/16/2009	Static Survey	StatRep		N/A	N/A	SLOStatA	2283-2492	QC Repeats (cont'd)

The primary objective of this report is to deliver to the program office and other interested parties (e.g., IDA, and data processing demonstrators) the following data:

1. **Target List:** A list of targets detected using the dynamic survey data for scoring by IDA.
2. **Static Training Data/Parameters**: Consisting of static data acquired over objects placed in the test pit and similar measurements made over the 10 items buried in the test strip, these data will be used by data processing demonstrators who plan to use their own software for parameter extraction and discrimination. We have processed these same data sets with our

own physics-based modeling program (MMRMP). Those results together with the ground-truth are provided with the data distribution.

3. **Static Survey Data/Parameters:** For all targets listed in the ***target list*** (see 1 above), we supply both data and the target parameters extracted using MMRMP. Also provided is an expanded target list that identifies each target pick with one or more static data files.

We trust that the explanations supplied in this report together with supplementary material that we have included with the data will allow the data processing demonstrators to proceed using their own independent techniques of target parameter extraction and/or discrimination.

2. Field Operations at SLO

All operations at SLO were conducted with the MetalMapper antenna array fixed to the front loader of a small Kabota diesel-powered tractor. The mounting arrangement is shown in the photograph in Figure 1. In the photograph, the antenna sled is shown mounted on wheels. A portion of the dynamic survey was run in this configuration. However, the N, NWA, NWB, and NWC areas were surveyed with the sled resting on its wooden runners. Running on sled runners causes the plane of the receiver cubes to be 21 cm above the ground level rather than 29 cm as it is when running with wheels.

Figure 1: The MetalMapper operating in dynamic (mapping) mode at SLO. Here, the front of the sled is supported by Rolleez™ low-pressure pneumatic wheels. We acquired some dynamic data without using the wheels. In the skid configuration (no wheels), the sensors are 8 cm closer to the ground surface.

2.1. Dynamic Survey

In accordance with our demonstration plan, the entire 11.8 acre site was surveyed with the MetalMapper operating in its dynamic mode. Data were acquired at a base frequency of 270 Hz along parallel survey lines with a nominal 0.75m separation. The survey speed was approximately 0.4 m/s and the sample rate was 10 samples/sec. In Figure 2, we show a base map of the demonstration area upon which we have plotted the survey lines. The Figure also shows how the 54-block demonstration site was divided into smaller survey areas and sub-areas. The definition of these survey areas and sub-areas was sometimes based on daily production (e.g., “NWA”), and sometimes based on a change in the direction of survey lines (e.g., area “NWB” and part of area“NWC” were surveyed on the same day). In some cases, problems in data processing required that a well-defined area be divided into 2 parts. Note that portions of the area were surveyed with N-S lines (e.g., areas NWA, NWB), with SW-NE lines (e.g., area NWC), with E-W lines (e.g., parts of area NE), and with NW-SE lines (e.g., area SE). Safety considerations in operating the Kabota tractor on some of the steeper slopes of the survey area required that we lay out the survey in such a way that the survey lines closely follow the fall line.

As an operational check of the MetalMapper system in dynamic mode operation, we surveyed the test strip twice daily. Each check survey consisted of 2 profiles over the test strip in opposite directions. During the course of the demonstration, we acquired 62 profiles (31 profile pairs). These data helped us to set the detection threshold, check latency, and have given us some sense of how well we can locate target sites with our survey and processing techniques. We briefly discuss some of those results in the next section.

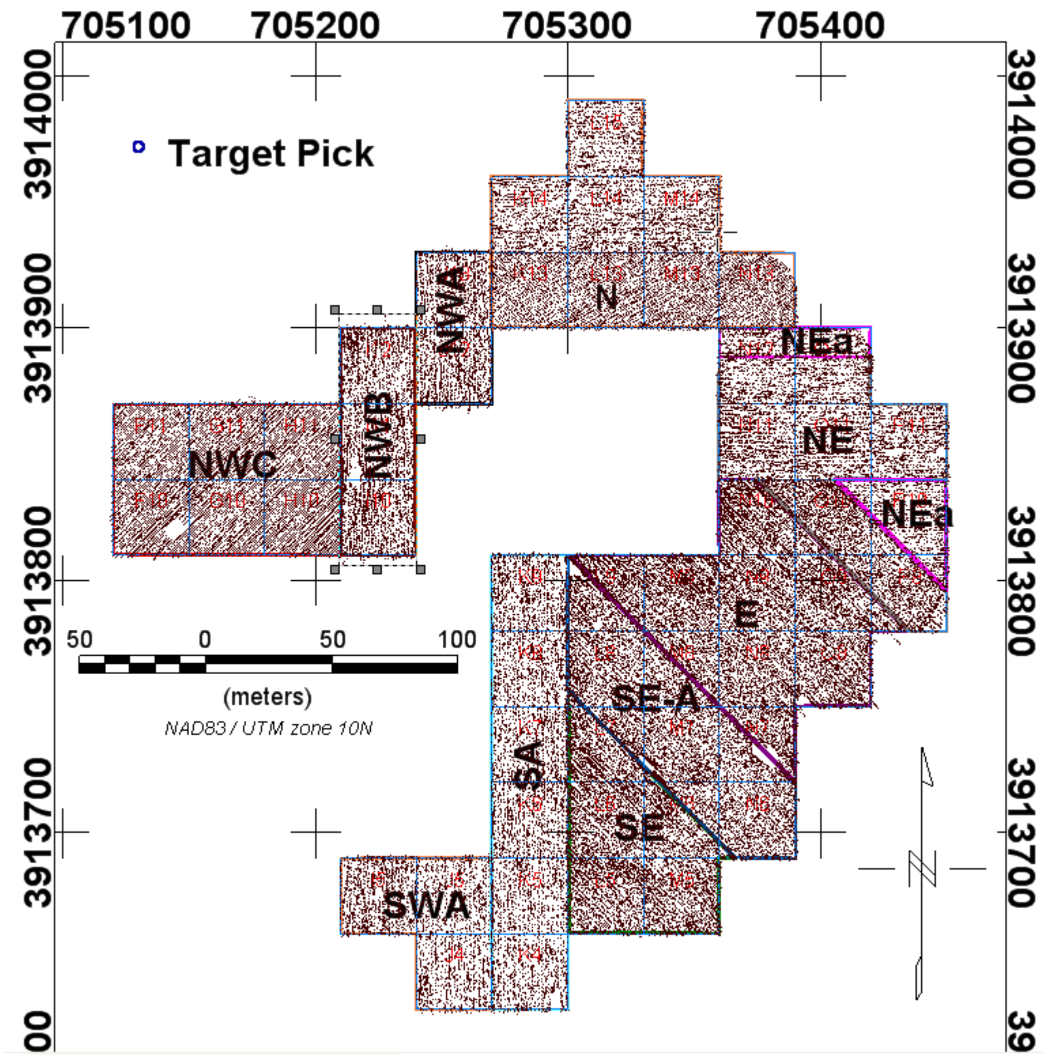


Figure 2: The SLO demonstration survey area that outlines each of the 30m x 30m survey blocks, the various *survey* and *sub-areas* defined during the MetalMapper detection survey, and the survey lines. Areas where there are "gaps" in line coverage correlate with outcroppings of bedrock.

2.2. Static Survey

A list of targets was compiled for each of the areas shown in Figure 2 by picking anomaly peaks with amplitudes above a specified threshold. In the static survey, we relocated each of the targets we picked in order to make a static measurement for the purpose of precision target parameter extraction. At San Luis Obispo, the static measurements were acquired at a base frequency of 30 Hz. A total of 270 repeat cycles are stacked for each of the 3 transmitter polarizations (X, Y, and Z). Each static takes approximately 27 seconds.

Over a period of 6.5 field days, we acquired a total of 2492 static measurements including 2178 targets that we picked from the detection maps that we compiled from the dynamic survey plus 7 new targets we picked during the inspection and plotting of the static survey points and 307 points we selected for repeat static acquisition. The production statistics for the static survey are in Table 2. In addition, we spent a half day acquiring static training data for targets of interest placed in the test pit (at different depths and attitudes) and made two runs over the 10 targets located in the test strip. Those data comprise the "training" data set that we have included with this report.

Table 2: Statistics for MetalMapper static survey production at San Luis Obispo.

Pt Type	Number	Time (days)	Time (hr)	Prod Rate	
				Pts/Day	Pts/hr
Orig Pick	2178				
New Pick	7				
Repeats	307				
Summary	**2492**	**6.5**	**56.6**	**383**	**44**

As a measure for quality control, we placed a shot put in the test pit. During the course of the static surveys we re-acquired the point where we located the shot put at least two times per day. Thus we were able to acquire 19 separate static measurements over the same target. Those data provide us with statistics on our ability to relocate a specific target and on the target parameters derived from the static data sets we acquired.

3. Dynamic Data Processing & Target Detection

All dynamic data files were processed using Geosoft Oasis montaj™ (OM) with the aid of Geosoft eXecutables (GX's), Geosoft scripts (GS's) and Geosoft expression files (EXP's) that allow us to import the binary data files into a Geosoft database and to generate the detection maps used for picking targets. Each of the 1061 data files acquired during the detection survey represents a line or profile in the survey of the total area. The dynamic data filenames all have a common root name, "SLODyn", to which is added a 5-digit sequence number (e.g., "00001") to form a unique name such as "SLODyn00001.tem".[1] To facilitate processing these data, we divided the files into sub-groups that are identified with smaller areas of the SLO demonstration area. The sub-groups of data files and the areas they belong to are indicated in Table 1. The location of each of the areas is shown on the base map in Figure 2.

The following basic processing steps are performed on each data files as they are imported into a Geosoft database (GDB) or immediately after importation:

1. Normalize all transient data by the appropriate loop current value.
2. Compute UTM coordinates from the GPS latitude/longitude.
3. Compute coordinate location of antenna array reference point using measurements of pitch and roll from the attitude sensor plus the cart heading, computed from successive GPS positions along the profile. The coordinate correction is based on a GPS antenna height of 1.48m directly above the cart reference point.[2] Note that when the MetalMapper is deployed

[1] The filenames for the static files are generated the same way. At San Luis Obispo, static data files all begin with "SLOStatA".

[2] The cart reference point is taken to be the geometric center of the Z transmitter coil and the 1.48m GPS antenna height is along a line perpendicular to the plane of the Z transmitter coil that passes through the reference point.

with wheels (see Figure 1), the cart reference point is 29cm above the ground level (AGL). When deployed on skids, the height of the reference point is 21 cm AGL.[3]

4. Compute a simple scalar detection parameter (Avg5IZ) defined as the average response of the Z components of the 5 MetalMapper sensor cubes closest to the center. Note that no background has been removed prior to computing the Avg5IZ map. In Figure 3 below, we

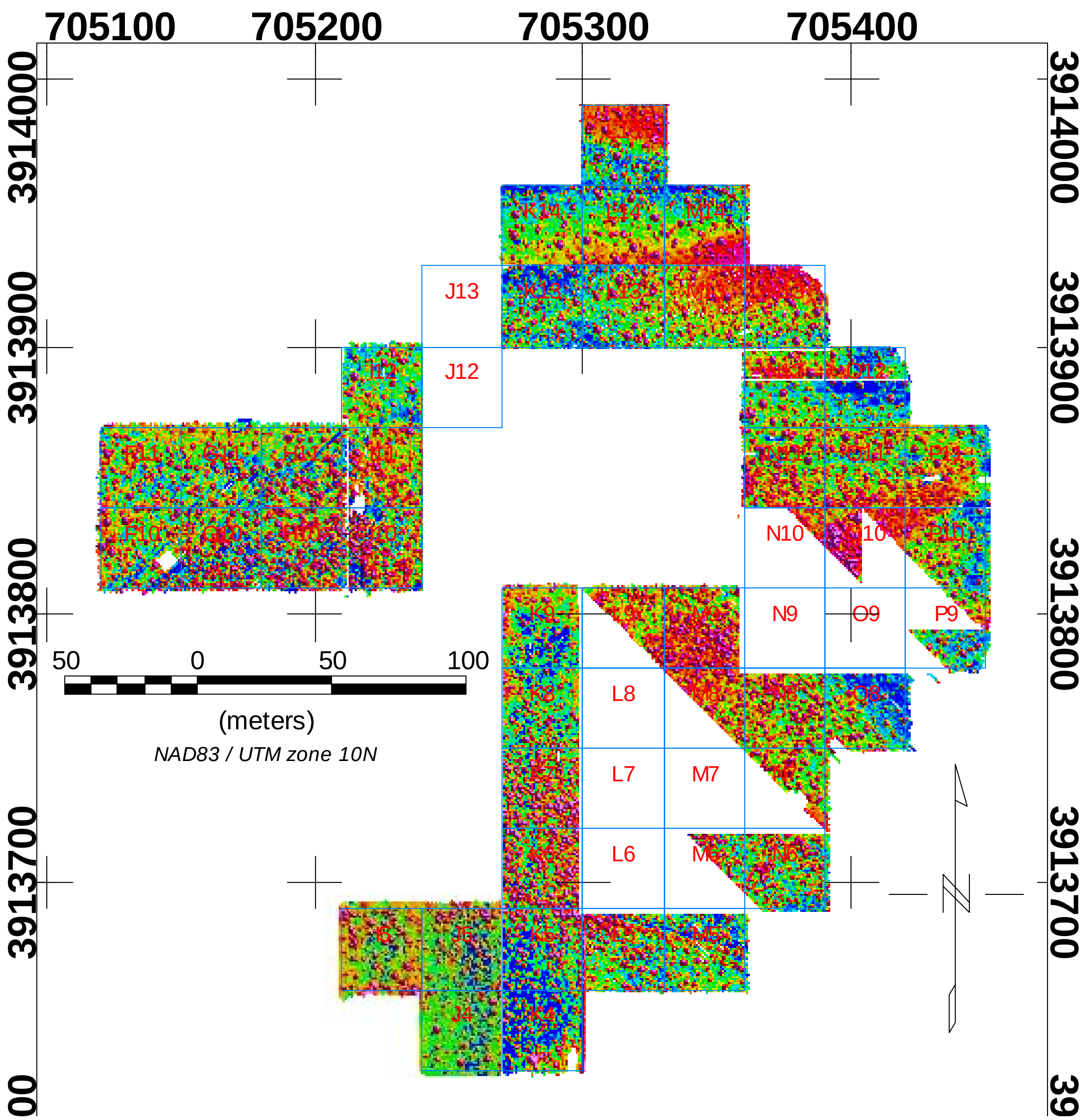


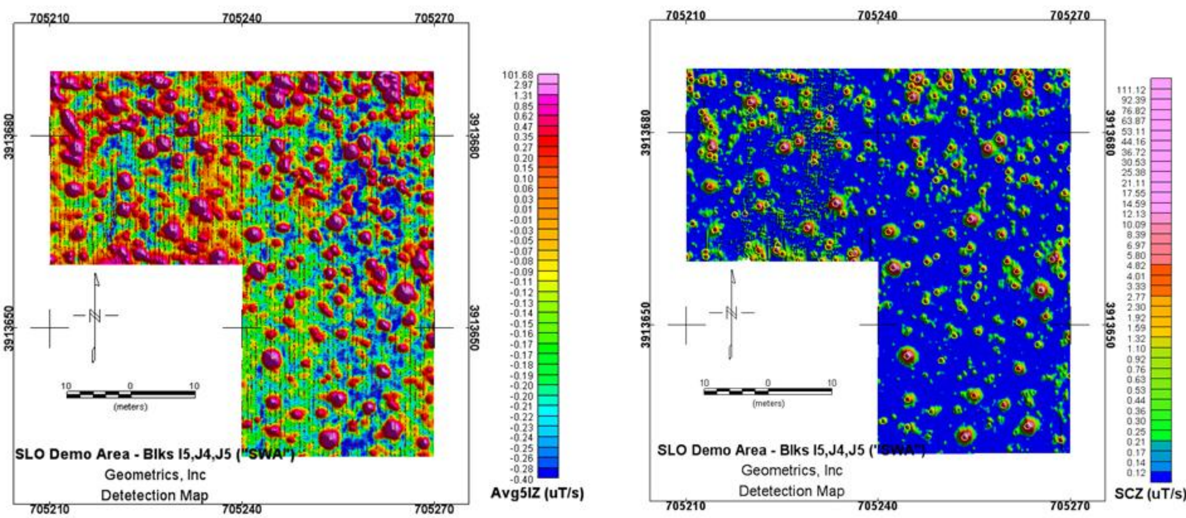
Figure 3: Base map of the SLO demonstration area overlaid with the "Avg5IZ" response maps for each of the sub-areas defined in the MetalMapper detection survey.

[3] All static data were acquired with the skid configuration. Dynamic data in areas "N", "NWA", "NWB", and "NWC" were also acquired with the skid configuration.

have composited the Avg5IZ grids for each of the sub-areas shown in Figure 2.

3.1. Split-Cube Mapping

To meet the survey specifications for the SLO detection survey (i.e., ½-m lane spacing w/ ¾-m maximum, it was necessary to apply a 2nd level of processing that allows us to split the response measured at each of 7 tri-axial cube sensors into 7 independent lines with appropriate adjustments for the offsets of each cube relative to the cart reference point. To generate a satisfactory split cube map requires that the background be removed from the response of each individual sensor. Once the background has been removed, a “SplitCube” GX is applied to generate another GDB in which each of the lines shown in Figure 2 has been split into a series of 7 lines with a line spacing of 13cm. Figure 4 below compares “Avg5IZ” maps with a split cube map for the SWA area of the survey. The split cube map meets the specifications for maximum lane separation whereas, the Avg5IZ detector fails that specification for even the slightest departure of the actual lane track from the planned 0.75m spacing.



Average 5 Inner Z (Avg5IZ) Map – Sub-area SWA

Split cube Z (SCZ) map – Sub-area SWA

Figure 4: Figure comparing the Avg5IZ map with the SCZ map for sub-area SWA of the SLO demonstration site. Under ideal circumstances (perfect 0.75m survey lane spacing) the effective lane spacing of the SCZ map is 13cm.

3.2. Detection Threshold Selection

A cursory glance at either of the detection maps suggests that there are many thousands of discrete targets falling well above the noise levels indicated by the data.[4] Therefore, it was necessary to set the threshold of detection on these maps well above the noise threshold. As required by the program office, we set the detection threshold based on the predicted response of the smallest target of interest (2.36-in rocket) in its least favorable orientation (horizontal) at a depth of 45cm below ground level. In Figure 5, we show a plot of the principal polarizability transients that were extracted from experimental free-air static data (acquired in the test pit at

[4] The noise level on a typical SCZ map such as the map in Figure 4 (right) is about 0.1 µT/s. That is more than 10X below the expected response for munitions of interest.

SLO) and static measurements over the 2 rockets buried in the test strip. The heavy colored curves represent the geometric mean of the three principal polarizability transients.

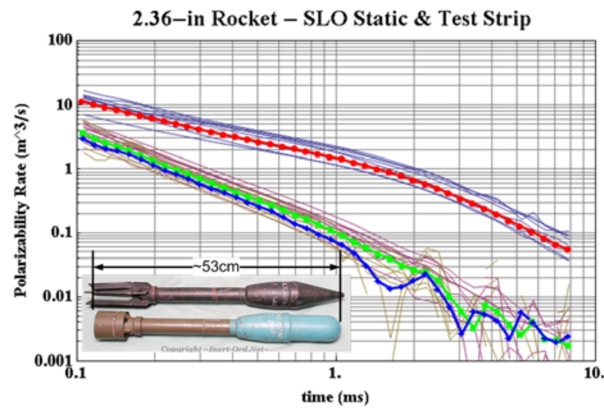


Figure 5: Principal polarizability curves extracted from static data acquired over 2.36-in rocket specimens at SLO. The red, green, and blue curves represent the three geometric mean curves calculated from all available measurements.

Using the polarizability curves from Figure 5, we approximated the average polarizability for the detection time gate that we used at SLO (100≤t≤926μs) and used the resulting scalar polarizabilities to model the expected response for a horizontal 2.36-in rocket as a function of depth when the MetalMapper is located directly above the target. The model results are shown in Figure 6, with the smaller curve representing the case for a horizontal target attitude . The plotted points indicate the position of the measured response over target T009, a horizontal 2.36-in rocket buried at a depth of 30cm below ground level in the test strip at SLO. Those two points are the average of approximately 30 test runs over the test strip with each sled configuration (i.e., skids/wheels) made during the course of our dynamic surveys. On the basis of those results, we selected 3 μT/s as the peak detection threshold for dynamic data acquired with the skid configuration. For data acquired with wheels (see Figure 1) we used 2 μT/s as the threshold.

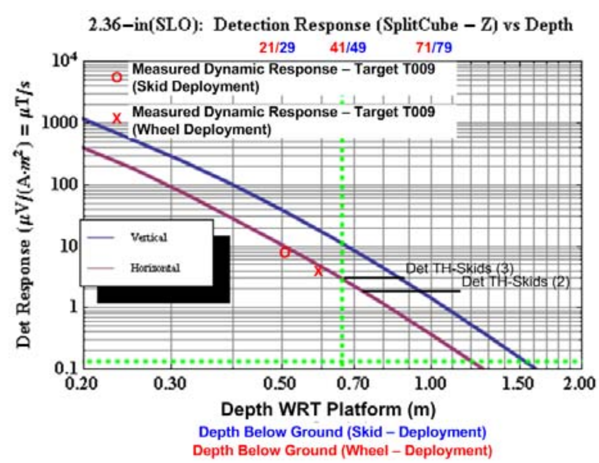


Figure 6: Plot showing the basis for selecting peak detection thresholds at SLO.

3.3. Peak Detection

We used the peak detection GX (gridpeak.gx) that is provided with OM to detect anomaly peaks. We set detection threshold at 1.5 μT/s. Then we sorted by peak amplitude and masked all targets having an amplitude less than 2 μT/s. In the 4 areas that were surveyed on skids, therefore, the target list we used for our cued ID survey contained many targets with peak amplitudes that are less than the 3 μT/s indicated Figure 6.

3.4. Excluded Areas

In an effort to keep minimize the number of targets on our target list, we were directed by the program office to exclude targets within the 8-block rectangular area defined in the ESTCP demonstration plan [2] as the "Vehicles Only" area. This we were able to do prior to our static survey. In addition, we were allowed to exclude targets falling within the boundaries of a polygonal area provided to us by the program office that outlines the "InsiteRoad_Boundary". Although we made approximately 40 measurements over targets within that boundary, we have excluded those targets from the list that we are submitting grading. The excluded areas can be seen on the SLO Target Map (Figure 7).

3.5. Target List Editing

Final editing of our target list involved the following steps:

1. Each of the target picks was assigned a "Target Number" that was biased by a 5-digit number tied to the specific area. This step was actually performed as part of the process of cueing the targets for re-acquisition. The target bias and its associated area/sub-area is tabulated in Table 3.
2. Each of the static data files was associated with a target number using a GX named UCEPROVE.GX (available only for licensed users of UX-Detect). The fine, medium, and maximum search tolerances for UCEPROVE were set to 0.25m, 0.5m, and 1m, respectively.

Table 3: A table showing the relationship between static file names, target numbers, and the survey area and sub-area name. The assigned target number is the sum of the target bias plus a decimal number <1000.

Static Area	Area	Sub-Area	Static Pt Nos	Tgt No. Bias	MDB File Name	PDF File Name
SLO_NWA	SLO_NWA	N/A	490-524	12000	AoI_tgt-SLO_NWA.mdb	SLO_NWS-Pcurves.pdf
SLO_NWB&NWC	SLO_NWB	N/A	218-363	13000	AoI_tgt-SLO_NWB.mdb	SLO_NWB&NWC-Pcurves.pdf
	SLO_NWC	SLO_NWCa	1-217	10000	AoI_tgt-SLO_NWC.mdb	
		SLO_NWCb	364-489	11000		
SLO_N	SLO_Nn	N/A	1860-2178	21000	AoI_tgt-SLO_N.mdb	SLO_N-Pcurves.pdf
	SLO_Ns			22000		
SLO_NEPlus	SLO_NE	N/A	525-795	15000	AoI_tgt-SLO_NEPlus.mdb	SLO_NEPlus-Pcurves.pdf
	SLO_NEa	N/A		14000		
SLO_E	SLO_E	N/A	796-952	16000	AoI_tgt-SLO_E.mdb	SLO_E-Pcurves.pdf
SLO_SEPlus	SLO_SE	N/A	1206-1434	18000	AoI_tgt-SLO_SEPlus.mdb	SLO_SEPlus-Pcurves.pdf
	SLO_SE-A	N/A		17000		
SLO_SPlus	SLO_SA	N/A	1435-1859	19000	AoI_tgt-SLO_Splus.mdb	SLO_Splus-Pcurves.pdf
	SLO_SWA	N/A		20000		
NewPts	N/A	N/A	see SLO_StatRep	0	AoI_tgt-SLO_StatRep.mdb	SLO_StatRep-Pcurves.pdf
SLO_StatRep	All	N/A	2179-2492	N/A	AoI_tgt-SLO_StatRep.mdb	SLO_StatRep-Pcurves.pdf
Notes:						
1	Target # = Target Bias + 3-digit sequential number (possibly fractional)					
2	7 new targets picked after review of 2178 pts (called NewPts). The points are included in SLO_StatRep.					
3	307 points repeated. Repeats based on platform offset from predicted target point (>0.4m) plus >85% Fit.					

3. Review target list and mask out obvious repeated target points. These targets were present due to hasty and incomplete review of the original picks made with GRIDPEAK.GX and because targets that occur along the boundaries of sub-areas were picked in both of the areas. As a result of this review, we were able to identify and remove 91 targets from our original target list.
4. We re-ran UCEPROVE.GX to get a final association of observed static data files with target numbers. As a final step and in an effort to further reduce the target list, we masked (i.e., removed from the active target list) all targets with target numbers in the ranges $10000 \leq TargetNumber < 14000$ and $21000 \leq TargetNumber < 23000$ having a peak anomaly amplitude of less than 3 $\mu T/s$. These targets reside in areas that were surveyed

using the skid configuration and therefore are subject to the higher detection threshold. This step reduced the number of targets in our target list to 1797 targets.

5. We excluded targets falling within the area defined by the polygon InsiteRoad_Boundary.ply, a polygonal area that outlines a road on the demonstration site. This step further reduced our target list by 43 targets. So the list we submit as part of this report contains a total of 1754 targets.

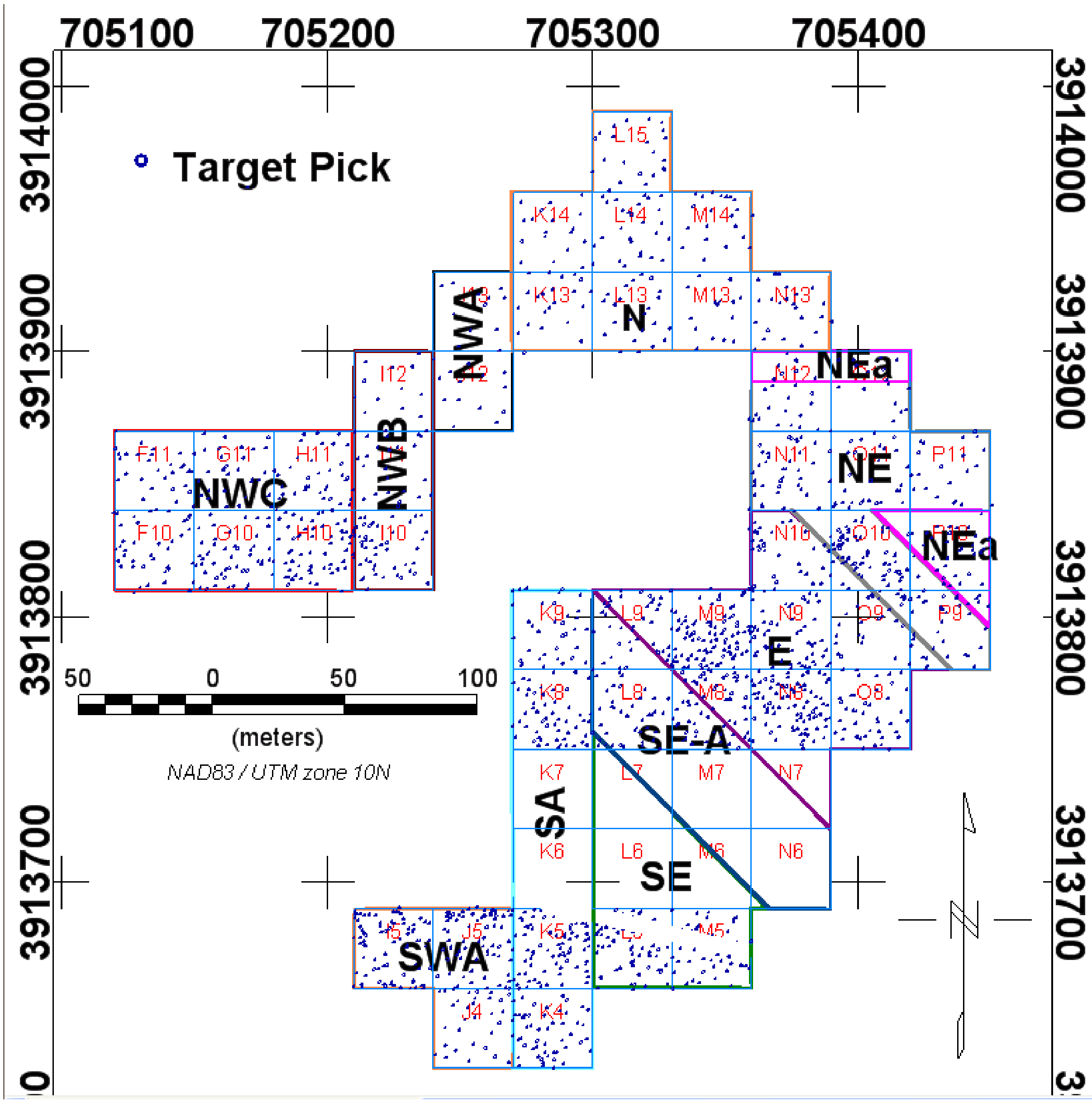


Figure 7: Figure showing the locations of 1754 targets on the target list generated from the MetalMapper detetion surveys. The targets have been intentionally excluded in the blank areas (blocks K6-N7; and diagonal strip running through blocks K5, L5, and M5).

In the course of the first target list review (made while static data acquisition was ongoing at SLO) we identified 7 new targets that were missed by the peak-picking software. And during post-acquisition review (steps 3 and 5) we identified another (8^{th}) target that we missed. Naturally, that 8^{th} (Target Number = 8) new target remains unidentified with a static data file. We also were unable to associate another of the new targets (Target Number = 7) with a data file. However, both these targets exceed the threshold for target detection and therefore they remain on our MetalMapper Target Detection List.

4. Static Data Reduction and Parameter Extraction

Each of the 2492 static data points acquired over the survey area were inverted with our dipole-based inversion program (MMRMP). The inversion engine for this software is a program developed by Torquil Smith [3]. Target parameters resulting from these inversions are stored in a series of MS-Access databases. The names of the databases are keyed to the sub-areas (e.g. "SLO_NWA.mdb"). We also inverted static data that we acquired over the test pit and the test strip. The databases are included in the data distribution.

4.1. Pre-Processed Data for Data-Processing Demonstrators

MMRMP can optionally generate a text formatted version of the static data point that it is currently inverting. The resulting post-processed data file retains the root name of the original binary data file (*.tem) and has the extension "*.csv". The "*.CSV" files differ in important respects from the original *.tem version. The following important pre-processing operations have been applied before writing the results to the corresponding "*.csv" file:

1. **UTM Coordinate Calculations**: The latitude and longitude for the data point are converted to UTM coordinates (zone 10). These coordinates represent the position of the GPS antenna (1.48m above the platform reference point).
2. **Coordinate Corrections**: Using the average magnetic heading, pitch, and roll angles, the UTM coordinates computed in step 1 are corrected to the position of the platform reference point. In making this correction, the magnetic heading was corrected with a declination of 13.5º to provide an estimate of the geographic heading of the platform.
3. **Background Removal:** A background data point is subtracted from the data so that the results written to the *.csv file has been corrected for background. To find out which background file has been removed, the user must consult the appropriate MMRMP target database. That information is stored in the Targets table.

4.2. Parameter Extraction

As we indicated in the introduction to this section, we store the target parameters resulting from the inversion of each static data set into an MS-Access database (MDB). An explanation of the database structure and a definition of the column headings for the 3 relevant tables of the target MDB is provided in the data distribution (see SLO_MMStaticData\Documents\ MMRMP_Manual.pdf). We have also provided a catalog of the polarizability graphics files that are generated in the course of each data inversion. As with the MDB files, the graphics catalogs are named to correspond with the appropriate sub-area (e.g., SLO_NWA-PCurves.pdf). We have also imbedded key words into each of the 9 PDF catalogs to aid in an indexed search of all

9 catalogs. The reader should consult the document SLO_PCurvesReadME.pdf to learn how to perform an indexed search.

For those familiar with MS-Access, the 9 MDB databases containing the results of our parameter extraction, one can use a capability of MS-Access called "Linked Databases" to affect a simultaneous query of all 9 databases. We have provided an example of a Linked Database (SLO_StaticMaster2003.mdb) with the other 9 MDB's. However, before using SLO_StaticMaster2003.mdb, the user must re-link the (27) tables in the master database with the correct location on the new computer. This is accomplished by using the "Linked Table Manager". Use of the master MDB for simultaneous queries over all 9 MDB's will be particularly important when the results of the target digs are provided for the first 4 30m x 30m survey grids.

4.3. Target-Lists & Ground Truth

For the training data, ground truth has been provided in the form of an MS-Excel spreadsheet (SLO_DemoSiteStaticTrainingGrndTruth.xlsx). As yet, there is ground-truth for survey area. All we can provide is the (expanded) target list that provides a cross-reference between the "Target Number" and a data file. When more than one data file corresponds to a single target pick ("Target Number") UCEPROVE.GX indicates those files in the column with the heading "Multi_Matched".

5. Summary

Over the 23-day period from May 25, 2009 to June 16, 2009 we conducted a field demonstration at the former Camp San Luis Obispo in California. During the demonstration, we performed a dynamic survey with a 0.75m lane spacing for the purpose of detecting metallic objects. Using grids generated from these data, we selected 2176 targets over which to acquire a precision static data set. At the end of the survey, we selected a 307 target subset of the original target picks for repeat measurements. The basis for selection was all targets with otherwise good SNR and good anomaly fit wherein the horizontal offset between target position and platform position exceeded 40cm. We also identified 8 targets that were not initially picked. We ended up with a total of 2492 static data measurements on a set of 2184 target picks.

As a result of post-acquisition review, we have been able to reduce the final target list to 1754 targets by

1. Identifying and excluding from the final target list obvious double picks 91 targets excluded).
2. Changing the peak detection threshold from 2 μT/s to 3 μT/s for targets in those sub-areas where the dynamic survey was performed on skids rather than wheels (~300+ targets excluded).
3. Excluding targets falling within the area designated as the "InsiteRoad" (~40 targets)

The demonstration achieved most of our Data Collection Objectives and Performance Objectives [1]. We will summarize those results in a final report.

6. References

[1] M. Prouty, "Detection and Classification with the MetalMapper™ at Former Camp San Luis Obispo," Geometrics, Inc, San Jose, CA, Draft Demonstration Plan2009.

[2] ESTCP, "2009 ESTCP UXO Classification Study, San Luis Obispo, CA," Environmental Security Technology Certifcation Program, Arlington, VA, Demonstration PlanApril 2009.

[3] J. T. Smith, H. Frank Morrison, "Estimating Equivalent Dipole Polarizabilities for the Inductive Response of Isolated Conductive Bodies," *IEEE Trans. Geosci. & Rem. Sens.*, vol. 42, pp. 1208-1214, 2004.

Appendix
MetalMapper -Static Data DVD
2009 ESTCP Classification Study, San Luis Obispo, CA

The DVD contains pre-processed static data files resulting from single-site static TEM measurements over targets detected by a dynamic-mode survey over the 11.8 acre demonstration site at the former Camp San Luis Obispo. We refer the reader to [1] (see .\Documents\ MM_DraftDemoPlanSLO_Final.pdf) for a description of the MetalMapper system.
The DVD contains 5 directories:

1. **Documents** – Relevant documentation concerning the SLO demonstration (e.g., demo plans) and the MetalMapper have been placed in this directory.
2. **MetalMapperConfiguration** – In this directory we have included the configuration file that we use with MMRMP for our parameter extraction. We also include a document (RMPEval.pdf) that contains an explanation of the configuration file.
3. **MMRMP_SLOTgtParams –** This directory contains the MS-Access databases resulting from the inversion of all the static survey data as well as the static training data for the SLO demonstration. An explanation of the structure of the database and the definitions for the columns in the 3 relevant database tables is contained in the document MMRMP_Manual.pdf. Plots of the principal polarizability curves have been cataloged into PDF files (e.g., SLO_StaticTrngPCurves.pdf).
4. **SLO_GndTruth&TargetList –** Contains the ground-truth for the training data set (SLO_DemoSiteStaticTrainingGrndTruth.xlsx) and the final Detection target list (SLO_AllTgts-6Jul09b.xlsx).
5. **StaticCSVData –** This contains pre-processed CSV text files for the Cued ID survey and for the static training data (test pit and test strip). In these data files, the position has been corrected for GPS antenna height based on measurements of the platform attitude angles (true heading, pitch, and roll). There are also CSV files containing estimates of the RMS noise values for the data sets. These files are derived from dynamic mode data files containing 100 or more unstacked data points. They have the same format as the regular CSV data files. Note that the time stamp on the CSV files reflects when the CSV file was made and not when the data were acquired. The data of acquisition of the noise files has been preserved in the file "RMSNoise.txt". One can also determine the date of acquisition using the field notes (see Documents\ SLOFieldNotesOpt.pdf).

The Target List

The target list (SLO_AllTgts-6Jul09b.xlsx) contains 3 sheets:

1. **SLO_AllTgts** – This sheet contains 2184 targets that have been matched with static data file names (column "Target_Matched"). The "Mask" column is used to identify those targets to be used in the final target list (Mask = 1). A blank in the Mask column signifies that the target is to be excluded.
2. **SLO_Tgts** – This sheet contains only targets that are to be included in the final target list (Mask = 1). Furthermore, we have only included a subset of the columns

provided in SLO_AllTgts. These columns may be helpful in sorting the targets according MetalMapper sub-areas, target numbers, or anomaly amplitude.

3. **ColHdr_Defs –** Contains a table that provides definitions for the column headings in the other two sheets.